

小型哺乳类食果动物可能对蛇菰科葛菌种子散布的初次报道

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摘要: 初次报道了哺乳类食果动物可能对蛇菰科葛菌 (*Balanophora harlandii*) 的种子散布, 葛菌具有酷似蘑菇且醒目显著的肉质佛焰状果序, 食菌的啮齿类动物很可能由于对其进行取食而起到种子散布的作用, 本文对此现象进行了初步探讨。

关键词: 寄生植物; 蛇菰科; 可能的食菌类; 啮齿动物; 种子散布

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A Preliminary Report of Small Mammal Frugivory on *Balanophora harlandii* (Balanophoraceae)

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Abstract: Mammal frugivory and apparent seed dispersal of *Balanophora harlandii* (Balanophoraceae) in Xishuangbanna, Yunnan Province, China is reported for the first time. The possibility of the conspicuous, fleshy, spadiceiform infructescences mimicking mushrooms for dispersal by mycophagous rodents is discussed.

Key words: Parasitic plants; Balanophoraceae; Possible Mycophagy; Rodents; Seed dispersal

Balanophora J. R. Forst. & G. Forst. (蛇菰属) is a genus of leafless holoparasitic plants in the Santalales (APG III, 2009), or related Balanophorales (Nickrent *et al.*, 2010). There are ~19 species, mainly in the Old World tropics and the Pacific Islands, with 12 species in China, one of which is endemic (Huang and Murata, 2003). The different species are either monoecious or dioecious and are subterranean root parasites on a range of hosts. They generally only emerge above ground to flower and fruit (Fig. 1), when they produce conspicuous, brightly-coloured, often mushroom-like spadiceiform inflorescences (Huang and Murata, 2003; XTBG, 2010).

Balanophora harlandii J. D. Hook. (葛菌) is a dioecious species that grows in shady, moist mountain forests between ~600–2 100 m in southern China, India and Thailand (Xing and Li, 1992; Huang and Murata, 2003), where the host plants are usually *Cannabis* (大麻属: Cannabaceae) and *Pueraria* (葛属: Fabaceae) species (Huang and Murata, 2003). Although used medicinally, *B. harlandii* is rare and considered threatened, mainly due to habitat loss or disturbance (XTBG, 2010). In China, flowering occurs from September to November, with fruits taking several months to mature. The inflorescence is a mass of tiny, more or less syncarpous fleshy±achenes, creating a vividly red, fleshy mush-

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room-like structure borne above the leaf litter on a short scape emerging from a cluster of leafy red bracts (Fig. 1B).

During floristic surveys for a range of plant groups in reserves around Xishuangbanna in southern Yunnan Province fruiting plants of *B. harlandii* were encountered where mature infructescences had been stripped of their achenes by small mammals, most probably rodents. Balanophoraceae fruit dispersal has been little studied, but seed dispersal by rodents has been suggested for at least one South American genus (Borchsenius and Olesen, 1990). Accordingly, the phenomenon is reported here for *Balanophora* and the possible role of fungal mimicry by the infructescences for mycophagy by rodents is discussed.

Materials and methods

As part of searches for various plant taxa for ongoing research projects between the CAS and University of Adelaide, treks through the native forests in the Xishuangbanna Tropical Botanic Gardens (XTBG), Menglun ($21^{\circ}41' N$, $101^{\circ}25' E$, 570 m); Rainforest bordering a creek running into the Nanlahe R., Bubeng near Mengla ($21^{\circ}36' N$ $101^{\circ}35' E$) were undertaken by both authors in Jan. 2008. During these searches, five clumps of *B. harlandii* were encountered, two at XTBG and three at Bubeng. All were growing at moderate altitude (7–800 m) and mostly in drier, bamboo-dominated rainforest forest margins.

At each *Balanophora* clump, the number of mature versus immature and damaged versus entire infructescences was recorded, as well as any damage. Due to the small numbers involved, both within clumps as well as due to the rarity of the colonies, the data were not amenable to detailed statistical analysis and this paper is intended as a preliminary report of the phenomenon requiring further investigation, rather than a conclusive study.

Results

Infructescence number varied from 3–8 ($4.6 \pm$

2.1 mean and SD), with 1–3 mature fruiting stalks present on each clump (Fig. 1A). Although most of the colonies appeared to be untouched, two (one each at XTBG and Bubeng) showed evidence of mammalian (probably rodent) frugivory, with several mature infructescences having been obviously chewed, more or less completely stripping them of the fleshy syncarpous achenes (Fig. 1C), as well as leaving a mass of seed-filled material on the ground surrounding the colony (Fig. 1D).

Discussion

Balanophoraceae dispersal

The presence of mature infructescences with conspicuous rodent damage is significant given the rarity of the species. Either this is an example of fruit predation, or it may represent part of the dispersal mechanism of the species. The fact that only mature fruits were targeted suggests possibly the latter, but it may also be a reflection of the food value and/or palatability of the infructescences at different stages of maturity.

Fruit dispersal in the family is little studied. Rain wash dispersal in Costa Rican Balanophoraceae was reported by Gómez (1983), but Borchsenius and Olesen (1990) reported that 100% of *L. mirabilis* fruits placed in water sank within 24 h. Nevertheless, they did suggest that the achenes may be transported short distances by water, as well as dispersed by rodents.

The fruits of *Dactylanthus taylorii* in New Zealand form small achenes with a tough, almost woody endocarp. The species is thought to be water or gravity dispersed (Ecroyd, 1996) and feeding on infructescences by introduced Kiore (*Rattus exulans*) is seen as detrimental to the survival of this endangered plant species (Ferreira, 2005).

Rodents, dispersal and predation

Rodents are common frugivores, though most rodent dispersal is thought to be a result of transporting and/or caching seeds and fruits for later consumption (Dennis and Westcott, 2006; Westcott *et al.*, 2009)

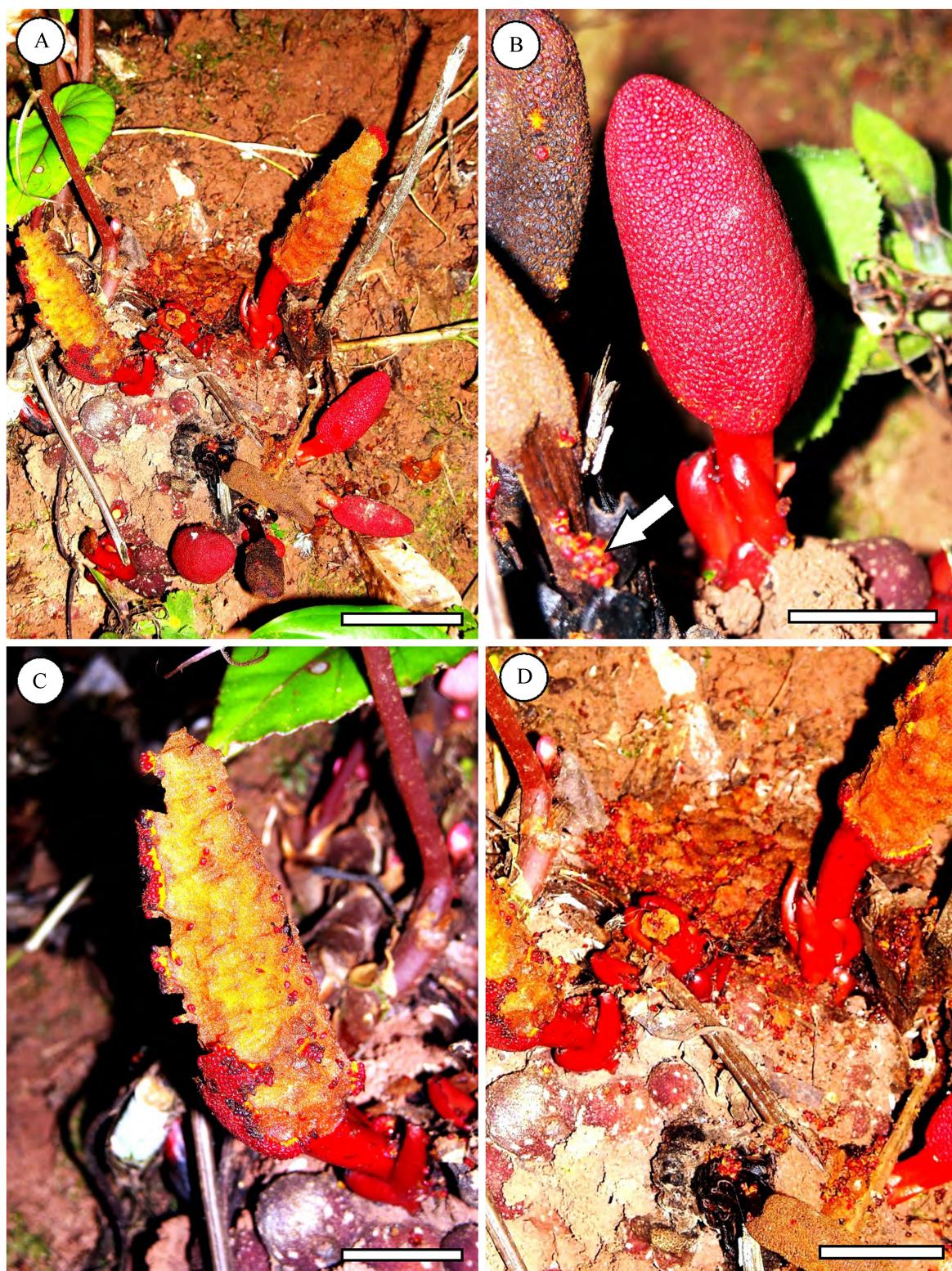


Fig. 1 *Balanophora harlandii* infructescences near Bubeng, Xishuangbanna, Yunnan

A. Colony showing fruits in different stages of maturity; B. Spadieiform, mushroom-like infructescence showing the more or less syncarpous, fleshy achenes and prominent inflorescence bracts below the scape, arrow indicates seed-bearing frass from rodent feeding; C. Mature fruiting body showing extensive damage and chew marks from small mammals, probably rodents; D. Seed-filled frass left behind after infructescence feeding by the small mammals. Scale bars A=50 mm, B-D=20 mm

and an example of dispersal through ineffective dyszoochory, with effective endozoochory in small mammals and especially rodents considered to be less common (van der Pijl, 1982; Traveset *et al.*, 2007).

Nogales *et al.* (2005) found that *Rubia fruticosa* (Rubiaceae) seeds ingested by squirrels (*Atlantoxerus getulus*) or rabbits (*Oryctolagus cuniculus*) showed significantly reduced viability and germination, possibly because of long gut retention times. This was also suggested for some mammal-dispersed endozoochorous seeds in the Mediterranean (Traveset *et al.*, 2001), but frugivore taxon versus germination results can vary widely (Traveset and Willson, 1997; Nogales *et al.*, 2005; Rodríguez-Pérez *et al.*, 2005), and even non-flying mammalian dispersers still showed reasonable, albeit lower germination levels. Nevertheless, in general although bat and bird dispersal encourages germination, non-flying mammals have only minor positive effects (Traveset and Verdú, 2002).

The small seeds of *Balanophora* may be able to avoid being chewed themselves when the fruits are being ingested and it is possible that they are being dispersed through the faeces of the rodents. The resemblance of the infructescences to fungi could well be an example of mimicry to attract mycophagous small mammals, which are known to disperse fungal spores in their faeces (Claridge and May, 1994), as well as seeds of the fungus-like subterranean orchid *Rhizanthella gardneri* (Orchidaceae) from Western Australia (Dixon, 2003). Similarly the tiny seeds of the root holoparasite *Cytinus hypocistis* (Cytinaceae) has been shown recently to be able to survive ingestion of the seeds by tenebrionid beetles (de Vega *et al.*, 2011). Some rainforest rodents are also known to disperse fungal fruiting bodies before consuming them (Dennis and Westcott, 2006; Westcott *et al.*, 2009).

The fact that frass from the chewed infructescences as left lying on the ground (Fig. 1D) also suggests that the damage may actually help fragment the syncarpia, which otherwise tend to become rather dry

and crustaceous at senescence (Huang and Murata, 2003), which would hinder seed dispersal. This would then allow more effective dispersal of the seeds by gravity or water away from the parent colony.

The presence of rodent damaged infructescences of *Balanophora harlandii* raises interesting questions needing further study and more direct observation. Is this an example of predation, making this rare species even rarer, or is it a case of mutualism, the rodents feeding on the fruits as if they were mushrooms and dispersing the small seeds? We hope that by reporting this phenomenon, further observations can be made to determine the answers to these questions, allowing for the limitations of studying rare and relatively hard to find taxa.

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